Strategic Use of Patents

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Background literature

- Study by Dietmar Harhoff, Bronwyn H. Hall, Georg von Graevenitz, Karin Hoisl, and Stefan Wagner for the European Commission. (July 2007 for ENTR/05/82)
- Hall and Ziedonis (2001)
- Ziedonis (2003)
- Noel and Schankerman (2007)
- Von Graevenitz, Harhoff and Wagner (2008)

Strategic Use of Patents

- Narrow definition – intended to identify anti-competitive uses of the patent system (Harhoff et al 2008):
  - Strategic use of the patent system arises whenever firms leverage complementarities between patents to attain a strategic advantage over technological rivals. This is anticompetitive if the main aim and effect of strategic use of the patent system is to decrease the efficiency of rival firms' production.

Ingredients

i) patents filed in a technology are *complements*;

ii) firms are building up *portfolios* of complementary patents;

iii) patent portfolios are employed to raise rival firms' costs of production.

(by means other than changing their R&D incentives)

Further definitions

- Portfolio – a set of patents owned by a single firm. Recall that innovations are often protected by several patents
- Complements – value in a portfolio exceeds the sum of the values when held by individual firms (and not cross-licensed)

Range of patent strategies

Portfolio maximization	Portfolio optimization	Protection of specific IP
Firms try to increase the size of their patent portfolio by filing large numbers of patent apps. Share of marginal pats high and opp/litigation relatively low.	Firms build patent portfolios with constant filing from a single priority; frequent opposition against competitors.	Patenting of specific R&D output with less emphasis on strategic mgmt of the portfolio; share of marginal pats low

Strategy	Portfolio maximization	Portfolio optimization	Specific IP protection
Prevalent in	Complex tech: Telecomms, IT, electrical	Discrete tech: Chemistry, pharma, food	Most remaining technology areas
Examples of firms	Infineon, Qualcom, NTT Docomo, Intel, IBM	L'Oreal, Beiersdorf, Schering, Henkel	n.a.
Volume of apps.	very high	high	average
Use of opp.	below average	above average	average
Use for blocking *only*	infrequent	frequent	average
Share of critical refs per claim	average	high	average
Use of divisionals	frequent	frequent	infrequent
Apps with shared priorities	average	above average	average

Anticompetitive strategy

- Portfolio maximization
  - More likely in complex technology sectors, where a single product relies on many patents, often held by different firms => complements.
- Review evidence:
  - Semiconductors
  - Software

Sidebar: weak patents

- Strategy facilitated by uncertainty and low quality patents
  - Farrell and Shapiro (2007) show that in the presence of downstream competition, incentives to challenge patents are sub-optimal if patents are probabilistic.
  - Problem is worse in the case of complements (profit at issue is much larger than the contribution of the patented technology).

Farrell and Shapiro (2007)

- Weak (low prob) patents licensed to downstream firms that are not rivals command low royalties
- Weak patents licensed to downstream firms that are rivals command large running royalties
  - Free-riding means litigation for invalidity too low
  - Royalties allow collusion to maintain monopoly price

Is this a new problem?

"In the manufacture with which I am connected – the sugar trade – there are somewhere like 300 or 400 patents. Now, how are we to know all these 400 patents? How are we to manage continually, in the natural process of making improvements in manufacture, to know which of these patents we are at any time conflicting with? So far as I know, we are not violating any patent; but really, if we are to be exceedingly earnest in the question, probably we would require to have a highly paid clerk in London continually analysing the various patents; and every year, by the multiplication of patents, this difficulty is becoming more formidable."

[Macfie, R.A., quoted in *Is the Granting of Patents for Inventions Conducive to the Interests of Trade?*, *Transactions of the National Association for the Promotion of Social Science* 661, 665 (1865) (George W. Hastings, ed.)]

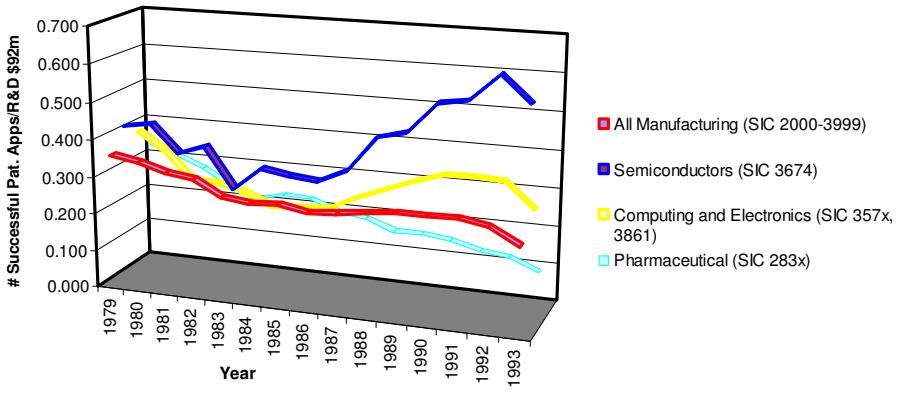
Semiconductors

- Hall and Ziedonis (2001) showed that patent portfolio racing in semiconductors began in 1984/1985 in response to changes in enforceability of US patents.
- Ziedonis (2004) showed that building up large portfolios was associated with fear of hold-up due to fragmented rights holders in the technologies used by the firm.

Hall and Ziedonis (*RJE* 2001)

- Increase in US patenting since early 1980s (now paralleled by increases at JPO and EPO)
- Survey evidence - patents ineffectual for firms in most industries
  - Yale Survey 1982
  - Carnegie Mellon Survey (CMS) 1994
  - Firms did not increase their reliance on patents for appropriating returns to R&D between these two surveys.
- Why did patenting increase in these industries?

Patent propensity: semiconductors vs. all US manufacturing, 1979-93



Summary of interview results

- Capital-intensive manufacturers
  - Strong demonstration effect of TI and Kodak-Polaroid cases
    - "Ramping up"; "harvesting latent inventions"
    - "If in doubt, patent"
  - Safeguard assets; avoid halt in production
    - "Exclude before you're excluded"
  - Improve bargaining position with other patent owners
    - Gain access to external technology on more favorable terms
    - Secure royalty income
  - Changes (except at TI) in management of patent process
    - "Patent advocacy committees"; increased bonuses; targets
- Design firms
  - Secure rights in niche product markets
  - Critical role of patents in attracting venture capital

Summary of econometric results

- Patent production function
  - Patenting proportional to size of firm
  - Until 1984: patents also depend on R&D intensity
  - After 1984: patents depend on capital intensity and not on R&D intensity
  - This pattern also true of computing, electronics, and instruments more broadly (Hall 2003)
- Growth accounting of the US patent surge shows that it is entirely due to increases in patenting by US corporations in this sector (until the mid-1990s, at least).

Conclusion

- Growth in patenting 1984-1994 driven by the need of firms with large (sunk) capital investments to prevent hold-up by competitors holding patents that they may infringe.

Ziedonis 2003

- Relates patenting of 70 semiconductor firms to
  - R&D intensity
  - Capital intensity
  - Fragmentation index – concentration measure based on the owners of patents cited by this firm's patents
  - Pre and post changes in 1983/84

Ziedonis 2003 - results

- Firms patent more aggressively when
  - Fragmentation index is high (they draw on technologies held by many other firms)
  - Especially if they also have high capital intensity (as in HZ 2001) – implying holdup is more expensive
  - Effects are stronger in post-1984 period, after shift in patent importance in the semi-conductor sector

Software

- Noel-Schankerman (2006) build a model of R&D, patenting, and firm market value where drivers are the nature of technological competition
- Model applied to software firms in the U.S. 1980-1999, confirming most predictions

Independent variables

- Rivals' patent propensity – weighted average of patent stock/R&D stock
- Tech concentration – 4 firm concentration ratio of the firm's citations to other firms' patents
- R&D Spillovers – weighted sum of R&D stock
- Weights are tech proximity, computed as cosine of the angle between the vector of patent classes cited by the firm and its own classes

Model prediction & result

	Endogenous variable:		
Exogenous variable:	R&D	Patents per R&D	Market value
Rivals' patent propensity	Negative 0	Negative -	Negative -
Tech concentration	Ambiguous -	Ambiguous -	Positive +
R&D spillovers	Ambiguous 0	Positive +	Positive +

Conclusions of NS 2006

- In software, the closer a firm is technologically to other firms with lots of R&D, the more it patents given its R&D, and the higher is its market value
  - Sub-sector effect? The 4 digit sector 7372 includes a variety of software firms, from Microsoft to much smaller niche players
  - Size or vertical integration effect? No size variable in the patents eq other than R&D
- Higher concentration in the firm's tech area reduces its R&D and patenting per R&D but increases its market value
  - Lower need for patents to prevent hold-up?
  - How is tech concentration related to product market concentration?
- Patenting by tech rivals reduces firm's R&D, patenting, and market value.

Patent thickets

- Von Graevenitz, Harhoff, and Wagner (2008) present a model of patenting in discrete and complex technologies and implement it using EPO data.
- Patenting is driven by
  - Technological opportunity
  - Complexity of the technological area
  - Patenting costs

Model

- In each tech area, a number of technological opportunities (Os) available
  - All the Os in an area have the same number of "facets" (Fs), each of which can be patented.
  - The value of the tech opp O to the firm depends on its share of patented facets, so firm value is

$$V(\bar{O}_i, F_i) = \left(\sum_o [s_{io} V(O) - L(s_{io})] - \text{R\&Dcost}_o - \text{patentfees}_o \right) - \text{coordcost}$$

where L is legal costs of settling disputes in O and s is firm i's patenting share in O

Game

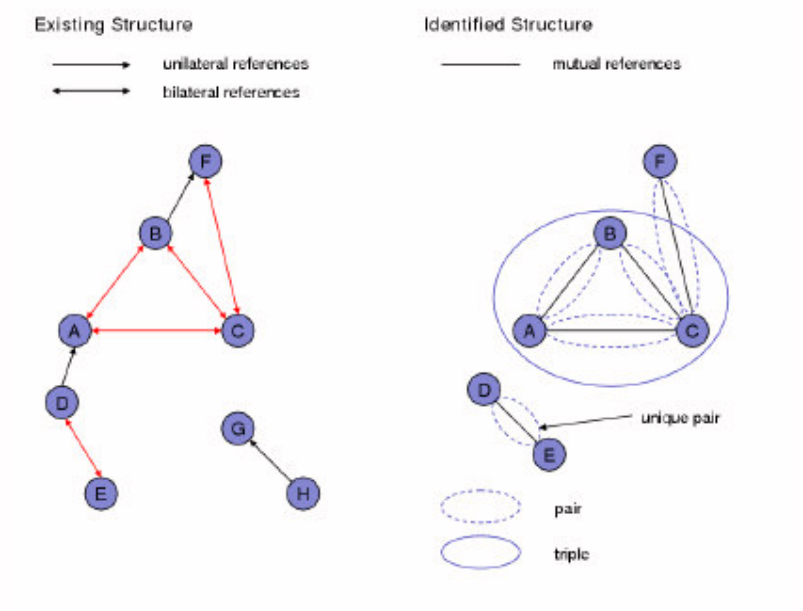
- N+1 firms
- Simultaneous moves to choose number of Os and Fs within Os to maximize payoff
- Payoff is twice differentiable and depends only on rivals' aggregate patent strategies
- Then firm strategy reduced to # of Os and average number of facets per opportunity
  - Within a tech area, patenting shares do not depend on which O(s) are picked.

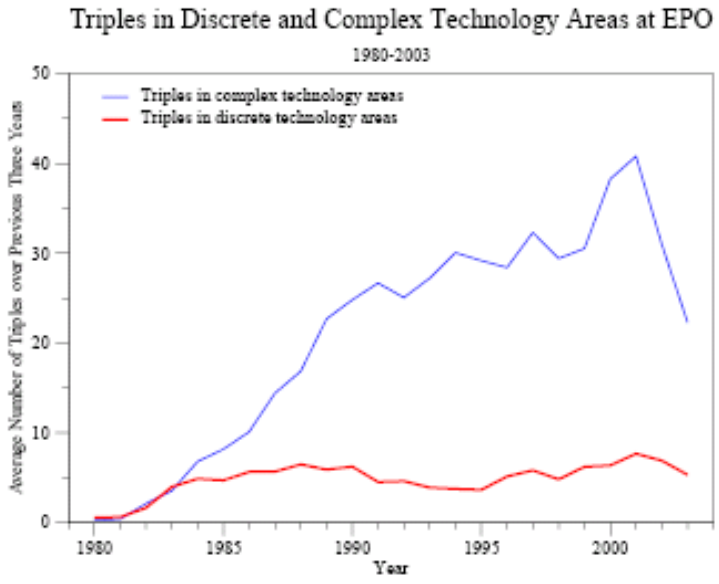
Model results

- Complex technologies (smooth supermodular game)
  - Cor. 1 – increase in N raises firm patenting as complexity grows
  - Prop. 2 – greater T. O. reduces firm patenting as complexity grows
- Discrete technologies
  - Cor. 2 – increase in N reduces firm patenting
  - Prop. 3 – greater T.O. increases firm patenting

Empirical implementation

- EPO data 1980-2003
- 30 technology areas (OST)
- Firms with >100 patents apps
- Unit of observation is firm-area-year
- Key variables:
  - Dep var - patent apps
  - Tech opportunity – average non-patent refs per patent in tech area and year
  - Complexity – triples in reciprocal X/Y refs
  - Fragmentation – Ziedonis measure, based only on X/Y refs


Existing Structure
unilateral references
bilateral references
Identified Structure
mutual references
F
B
A
C
D
E
G
H
unique pair
pair
triple


Triples in Discrete and Complex Technology Areas at EPO
1980-2003
Triples in complex technology areas
Triples in discrete technology areas
Average Number of Triples over Previous Three Years
0
10
20
30
40
50
1980
1985
1990
1995
2000
Year

Results of vGHW 2008

- Predictions of model confirmed
- Variations in tech oppty have big impact, with opposite signs in discrete and complex technologies
- Blocking measure discriminates well
- As in Ziedonis, greater fragmentation of ownership increases patenting in complex technologies